TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 279

PROVISIONAL RULES FOR THE INSPECTION OF AIRCRAFT ADOPTED BY THE FRENCH BUREAU VERITAS.

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General Considerations.

These new regulations are intended to replace those of November 1, 1922, and give the directions to be followed in the supervision of aircraft by the agents of the Aeronautical Section of the Bureau Véritas.

In the present state of aeronautical construction and of measuring instruments, it is not yet possible to reach the goal desired, which is to impose rules permitting in each case absolute determination of the moment when repairs and replacements should be made.

The value of the supervision is still largely dependent upon the professional knowledge of the inspectors. These men should be impressed with the importance of their work and inspired by the purpose of the present rules. They should never lose sight of the fact that although safety depends in a large degree on the severity of their inspection, the greatest importance must nevertheless be given to the necessities of commercial use. They should therefore endeavor to exercise a "preventive" control and avoid, except in case of necessity, sudden decisions which may bring difficulties from the commercial standpoint.

The present rules consist of four sections. The first deals with the conditions imposed by the rules of the Air Navigation

Service in order that an aircraft leaving a repair shop should be able to retain its certificate of airworthiness.

The second section gives the objects of the quarterly and weekly inspections made by the experts of the Bureau Véritas. These inspections include a detailed examination of all the parts of the airplane. It is evidently impossible materially, to make such complete inspections for each airplane. It is the duty of the agents to devote their attention particularly to the parts which a cursory examination will reveal as those most subject to wear and in all cases to establish a certain rotation between the parts visited during the course of successive inspections for the same airplane.

The last two sections give the rules which should be followed in the upkeep and repair of airplanes. An appendix defines the changes from the prototype which entail new presentation to the Service Technique de l'Aeronautique. The terminology proposed by the Commission of Standardization of Terms and Symbols in Technical Aeronautics has been followed.

I. Certificate of Airworthiness.

The aircraft under the control of the Bureau Véritas must obtain before being placed in service a certificate of airworthiness, which is delivered by the Air Navigation Service on the receipt of advice from the Aeronautical Technical Service if the aircraft is of a new type, and from the Aircraft Production Service or the

Bureau Véritas if the aircraft is of a production type. The agents of the Bureau Véritas must be certain that the conditions imposed by the "Instructions Determining the Conditions for the Delivery of Airworthiness Certificates for Aircraft" (Ministerial Decree 1124/2A of February 19, 1923) are complied with. This verification should take place particularly during the course of repairs made in the workshops of the Air Navigation Companies where the Bureau Véritas is responsible for the inspection. The verification should include the inspection of new parts intended for replacement and the tests of engines repaired or reconditioned in the workshops.

It is necessary to be assured of the following conditions:

Changes - 1. No modification is to be made which might change the design of the airplane from that of the prototype, at all events unless such change has been authorized by the Aeronautical Technical Service.

R.P.M. - 2. The limiting speed (R.P.M.) of each engine (which must not be greater than 29/30 of the R.P.M. corresponding to the normal HP) is to be marked by a red arrow on the tachometer placed in view of the mechanic.

Switches - 3. There is to be one switch and one throttle lever per engine with in addition a general switch for the entire power plant and one gasoline cock per tank controlled by the pilot. There must be no rubber washer in the cock.

Propellers-4. The propellers are to be so arranged that the tips of

their blades are at least 0.40 m (1.31 ft.) from the ground for transport airplanes, and 0.25 m (9.8 in.) for touring airplanes when the airplane is in line of flight on the ground with the shock absorbers stretched to their limit. There is to be a minimum play of 0.05 m per meter of propeller diameter between the plane of the blade at its tip and any other parts of the airplane with which the propeller might come into contact in bending.

The passengers, crew, and vital mechanism of the airplane such as the controls, placed in a space comprised between the plane of rotation of a propeller and a cone of 150° opening with its apex at the hub and opening forward, are to be properly protected.

The propellers must carry the stamps of the Aircraft Production Service and the indication of the type of airplane, the use for which it is designed and the date of its construction.

Radiators - 5. The radiators, if provided, are to be furnished with a thermometer, placed in view of the mechanic, giving the temperature of the water as it leaves the cylinder heads. If the radiators are provided with a system of regulating the cooling surfaces, which is desirable, this arrangement should return automatically to the position of maximum cooling in case of breakage of its controls.

Exhaust Pipes - 6. The exhaust manifolds and pipes are to be insulated from other parts of the airplane by an incombustible non-heat-conducting covering, permitting inspection of the protected parts or by an air space of at least 40 mm (1.57 in.).

These pipes are to be so arranged that they cannot be sprayed accidentally with fuel, and the opening of the exhaust pipe is to be so placed that the gases can not reach any combustible part of the airplane.

The metal of the exhaust manifolds and pipes should be in proper condition and show no signs of deterioration due to rust or oxidation. The exhaust pipes not attached directly to the cylinder should possess supplementary means of securing (piano wires, etc.) sufficient to prevent their being torn off by the wind in case of breakage of the attaching bolts. This regulation is particularly important for pusher type engines.

Carburetors - 7. The air intakes of the carburetors must lead to the outside of the fuselage and are to be provided with anti-backfire devices or equivalent arrangements. The portions of the airplane in their immediate vicinity should be of metal or protected by metal covering.

Gasoline drains must lead to the exterior at all low points from which air might be taken in, on the ground or in flight.

The carburetors are to be fuel-tight or provided with an overflow leading to the exterior and their operation is to be assured for all positions and conditions of flight.

There should also be placed on board at least one extinguisher so mounted as to enable the pilot to quench the beginning of a fire at any one of the carburetors.

Wiring - 8. The ignition wiring is to be electrically insulated and so arranged as not to be damaged by the heat of the engines

or by having fuel come in contact with it; no fuel connection should be placed above an electrical wiring.

Ventilation - 9. The ventilation of the engine cowls is to be sufficient to avoid accumulation of carbureted gas in the interior.

Markings - 10. The airplane is to carry on a visible plate:

The total weight loaded,

The weight empty,

The maximum load of fuel,

and for airplane of public transport:

The maximum number of passengers permitted,

The maximum load of freight allowed.

Instruments - 11. Every touring airplane is to have in the pilot's cockpit:

One altimeter,

One speed indicator,

One compass.

Every public transport airplane is to have at the pilot's station:

One compensated liquid compass,

One recording altimeter,

A gyroscopic inclinometer,

One watch,

One speed indicator,

The Pitot tube of the speed indicator is to be placed in a po-

sition particularly free from eddies, etc. It is especially important not to place it in the propeller wake, near a wireless windmill, etc. If it is placed on a wing it should be at least 1/10 of the wing chord forward of the leading edge. If it is of the Badin type with piping of small diameter the length of piping is not to exceed 6 m (19.7 ft.). On seaplanes the Pitots are to be rustproof.

Each engine is to be provided with a recording tachometer easily read by the person responsible for the running of the engine.

Every airplane must carry signalling and position lights called for by the regulations of August 26, 1920. For airplanes intended for flying over the sea, there is to be provided one life-belt per person on board.

Every public transport airplane with closed cabin is to be provided with a safety panel which can rapidly be opened from the inside to permit exit even in case of deformation of the cabin after a landing accident.

A first aid medical case must be installed.

For technical visits it is sufficient to verify the existence of the necessary installations for immediately putting in place the control and navigating instruments.

II. Inspection.

A - Planes.

1. Wings.

(a) Verify the good condition of the fabric and the dope.

Inspect the top and bottom surfaces particularly in the forward 1/3 of the wing. There should be no tears in the fabric and it should be of normal tautness.

Under the pressure of the palm of the hand the fabric should yield and return to its first position as soon as the pressure is removed. The dope should not crack.

In case of doubt as to the state of preservation and until the development of measuring instruments which can be used on the airplane, two samples 0.20 m (7.87 in.) long and 0.06 m (2.36 in.) wide must be taken for tests, one following the warp and one the filling.

(b) The ribs should not yield under the hand or point across the cloth. The rear of the ribs should be lifted slightly to be sure that their attachment to the rear spar is in good condition. No abnormal play should be visible.

Be sure that the wire trailing edges are not broken.

(c) The wrinkling of the fabric indicates that one of the internal parts of the wing is broken (diagonal wires, ribs, etc.), the hand to be pressed heavily on the wrinkled section to endeavor to determine the nature of the breakage.

Be sure that the interior cross bracing wires are not broken by stressing alternately the front and rear of the wing.

(d) The wing spars should be straight. The spar which will not become so during an adjustment should be replaced (tolerance 3 mm deflection per meter = 1/333).

2. Tail Surfaces.

(a) Inspect the tail surfaces in the same manner as the main planes.

(b) Verify the attachment of the stabilizer and fins to the fuselage.

3. Struts.

(a) Be sure that the struts are not bent. A bent strut which does not become straight in the adjustment of the cell is to be replaced (tolerance 3 mm per meter = 1/333).

(b) The struts, the paint or varnish of which has given way, should be carefully examined after local scraping. If the wood flakes off the struts should be changed.

4. Wiring.

(a) The hand should be pressed against the flying wires which should have a spring-back action; the landing wires should be a little more rigid.

Note the tension by the tensiometer which allows verification of the quality of tension in double wires. Verify the tension on drag and anti-drag wires which should have the same tension.

A single cable or piano wire should not emit an appreciable sound when vibrating.

(b) When the wires are terminated by loops be sure that these are not deformed after the construction as that would indicate abnormal stresses.

Be sure that the wires are well locked in position and carry

no traces of rust.

(c) All wires which cross each other should be bound together at the crossing in order to prevent wear by vibration.

(d) The wires should be painted or oiled (the latter is preferable). The filler pieces between the wires should be held in position from place to place by wrapped and glued bands.

(e) The threading of the turnbuckles should be clean, without rust and greased. A minimum of five threads should be engaged; they should have no play in their casing and should not press against the end. The turnbuckles should be locked in position. The blocking screws should be locked by Grower washers or split pins.

(f) The shafts and clips should be clean and in good condition.

(g) The piano wires or cables in the proximity of the propellers should be covered with annealed wire, the ends of which to be firmly fixed.

5. Rigging.

(a) Take up a position forward of the airplane and successively in front of each strut.

Be sure that there is no bending and that the forward strut is in perfect alignment with the rear strut (tolerance for bending 3 mm per meter of length = 1/333).

(b) Take up a position at each end of the wing and verify the alignment of the struts.

(c) Remain in the same position and be sure that the leading edges have no abnormal deviation and are parallel to the trailing

edges.

(d) Verify the points of attachment of the wing roots to the fuselage of the airplane (cables and wing spars).

(e) Be sure that the aileron hinges are in good condition, clean and greased, and that the axes of the hinges are held by split pins.

(f) Be sure of the good tension of the cables by means of a tension meter.

(g) Utilize graduated scales, goniometers, spirit levels, plumb lines, etc., to verify the accuracy of the rigging. The verification of the angle of incidence should be made in the plane of the struts, the airplane being in line of flight.

B - Body

1. Fuselage.

(a) The condition of the longerons, struts and bracing wires composing the body of the airplane is to be examined as far as the fabric covering permits.

The struts should be parallel. If this is not the case the rigging of the airplane is to be done again.

Piano wires which cross at the same point should be of equal tension.

Verify the attachment of the formers and stringers of the body and the attachment of the cloth.

(b) Bodies of three-ply made up on a form should not show any protuberances, cavities or ungluing.

(c) For hulls, verify by the inspection holes the condition and water-tightness of the various compartments. Examine the condition of the bottom of the hull, particularly in the neighborhood of the steps and external ribs. The three-ply should not show any blisters.

Be sure that the center line keel is not worn and projects sufficiently to protect the bottom of the hull.

(d) The wing engine nacelles are to be examined in the same manner as the central fuselage.

2. Engine Bearers.

(a) The engine bearers should not show any deformation or flattening.

(b) The assembly should be in good condition. The bolts working in shear should be carefully examined.

All bolts should be properly secured with split pins.

(c) Examine the attachment of the engine cowling.

3. Cabin.

(a) The windows are to be of Triplex glass or similar product.

(b) The emergency exit panels are to be in good condition and operate satisfactorily.

(c) The seats are to be properly fixed.

(d) The door is to be closed properly and be easily opened from the inside.

(e) In airplanes for flying over sea and in seaplanes there is to be one life-belt per passenger and per member of the crew, con-

veniently placed for each person. Further, luggage and merchandise should have in principle a special hold permitting good trimming of the airplane.

4. Attachments of Wings and Tail.

(a) Verify sockets or attachment fittings of the wing spars.

(b) Verify the attachment to the fuselage of the stabilizer and tail fin.

(c) Verify the points of attachment of the wires.

5. Wiring.

Same regulations as for the wiring of the wings under "Planes."

6. Rigging.

(a) Be sure that there is no deformation of the body.

Verify that the angle of incidence of the stabilizer with respect to that of the wings conforms to the rigging instructions of the airplane.

(b) Seen from the front or the rear of the body the struts should be parallel to a vertical plane, the cross braces to the horizontal plane.

The struts should be strictly parallel, the cross bracing likewise.

(c) Determine by means of the goniometer the angle of incidence of the tail plane.

C - Landing Gear.

1. Struts.

(a) No strut should be perceptibly bent (tolerance 3 mm = 1/333).

(b) Verify the attachments and fittings of the struts.

2. Axles.

(a) The axles should be in good condition (neither bent nor straightened).

(b) Verify the bearing surfaces.

3. Wheels.

(a) Verify the alignment of the wheels, that the wires are sufficiently inflated, that the covers are not damaged by oil or gasoline.

(b) Verify the means of securing the wheels and their lubrication.

4. Floats.

Same verification as for hulls under "Body."

5. Skid.

Be sure that the articulation of the rear skid is satisfactory and that the mechanism is in good condition and that the metal piece in contact with the ground is not abnormally worn.

6. Shock Absorbers.

(a) Be sure that the shock absorbers support the wheels with the airplane loaded and in its lowest position.

(b) Be sure that the Sandow rubber cord is in good condition.

(c) Be sure that the airplane is provided with stops to prevent excessive shock absorber movements or that safety wires are fitted.

7. Wiring.

(a) Same regulations as for the wiring of the wing structure.

(b) The wires crossing at one point should be under normal tension.

8. Rigging.

The landing gear should be symmetrically arranged with respect to the fuselage.

D -- Controls.

1. Pilot's position.

(a) Be sure that the pilot's seat is provided with a safety belt.

(b) Verify the attachment of the cushions of the pilot's seat.

(c) Verify the installation of the aircraft instruments.

(d) Sit in the pilot's seat and operate the controls which should have no stiffness; be sure of their good operation and in particular, verify that they have no abnormal play.

2. Control Surfaces.

(a) Verify the fabric covering as in the case of the wings.

(b) Verify the operation of the elevators, the movement of which should be equal in both directions.

(c) Be sure that the rudders and elevators have no abnormal deformation.

(d) Be sure that the hinges of the rudders, stabilizers and ailerons are not worn, are in good condition, clean and greased, and that their axes are secured by pins.

3. Cable or Control Rods.

(a) Verify the splices at the points of attachment.

Verify the sheaves and be sure that there is no wear.

Verify the lubrication at all points of friction.

(b) All nonrigid controls should be in duplicate.

If the controls are of cable take them between the fingers and follow them along their entire length as far as possible (in the direction opposite to the torsion of the cable). Be sure that no strand is broken.

If the control is by wheel and includes a chain, be sure that it is under sufficient tension not to jump off the gear and sufficiently flexible not to make the control hard.

The pins of the chain should be without abnormal play. (This is to be verified by bringing two links together.)

In general the controls should be led so that they can not be jammed.

The splices at the attachment to the king posts or horns should be in good condition and furnished with a lacing wire.

Piano wires should not make an angle of less than 140° when passing through a guide or over a pulley.

The loops of the piano wire controls should not show excessive stretch and the nooses or strands should not be enlarged.

The holes of the axes of the fork joints of rigid controls should not become oval.

4. Axes, Hinges.

(a) Be sure that the hinges of the control surfaces are not abnormally worn, are in good condition, clean and greased.

(b) The axes of the controls should not have abnormal play; they should be clean and greased. Each axis should be secured by a pin against a flat washer.

E - Power Plant.

Bearers.

Be sure that the engine bearers are not out of alignment or flattened. Verify that the rods, plates, bolts and screws securing the engine to the airplane are in good condition, pinned and blocked.

Crankcase.

Verify the condition of the attachment studs holding the crankcase. Be sure that the nuts are properly tightened.

Cylinders, Pistons and Connecting Rods.

Verify the tightening of the holding down bolts of the cylinders and their blocking. Turn the engine by hand and verify the compression of each cylinder by removing successively the plugs of the other cylinders.

When all the plugs are in position the compression is good; if an increasing resistance is felt in turning the propeller and the propeller oscillates once, this point of resistance is passed.

Verify at the same time that the engine offers no abnormal resistance due to the connecting rods and that there is no abnormal metallic noise which might indicate torsion or a crack.

Distribution.

Verify the seatings of the valves. Be sure of their tightness. If the valves are accessible this tightness can be verified by pouring a little fuel on the valves when they are closed (a leaky valve allows very visible bubbles of air to appear in the fuel or the fuel enters the cylinder when the piston descends).

Be sure that the push rods slide easily in their guides, that the springs are in good condition, and close the valves strongly.

Test the tappets and rocker arms. Be sure that the latter are not cracked nor warped and verify that the play between the rocker arm and the push rod is normal.

Verify the blocking of the push rods.

Verify the condition of the inlet and exhaust piping and the tightness of the joints.

The exhaust manifolds or pipes placed at least 2 cm (.79 in.) from other parts of the airplane should be covered with an incombustible non-heat-conducting material allowing easy inspection of the protected parts. The metal of these parts should be in good condition and show no damage due to rust or oxidation.

Carburetor.

Verify the attachment of the carburetor and that of joints of the fuel inlet piping.

Be sure that the jet is well screwed down if it is accessible and that it is not stopped up.

Verify the good operation of the float by raising the needle

valve.

Be sure of the good condition of the filter.

Be sure that the air inlets of the carburetors lead to the exterior of the fuselage and that they are provided with an anti-backfire device.

Piping.

The india rubber piping should be in good condition, that is, it should yield to the fingers and show no flaws or breakages. The sections of connected tubes should not be more than 5 mm (.197 in.) apart if of small diameter. The rubber joints should largely overlap the junction and be fixed either by clips or by several turns of annealed wire.

Ignition.

Verify the operation of the magneto to see that it is good when in position and be sure of the condition of the driving pinions if they are accessible.

Be sure that the magnetos are greased periodically (generally every 10 hours of operation).

Breaker Mechanism.

Remove the cover of the breaker device and be sure that all the parts are in good condition and free from oil or moisture.

Verify the contact of the platinum points which should be flat over the entire surface and perpendicular to the axis of the platinum points.

Be sure that the platinum has not worn so as to allow the

silver used for soldering to be visible.

Be sure that the rocking lever is not jammed on its axis and drops properly after having been raised by hand.

Be sure of the tightening of the screw of the adjustable platinum point and of the central screw securing the breaker device.

Verify the condition of the carbon ground and of its spring.

Distributor.

Verify the condition of the distributor. Be sure that the path of the carbon is not fouled by dust produced by the wearing of the carbon.

When the carbon is demounted it should show a flat end. The spring should be flexible and should slide freely in its housing.

Regulation of the Ignition.

Plugs.

Verify the condition of each plug. The electrodes should be spaced about 4/10 mm (.016 in.) apart. Be sure of the good condition of the porcelain which should present no evidence of cracking.

Verify the condition of the plugs to see that it is good, by mounting them in a test tank, the pressure in which is from 4 to 5 kg (8.82 to 11 lb.). The tank is furnished with glass peepholes. The spark obtained with a test magneto should be clear and of a slightly bluish color.

Ignition Wiring.

Be sure of the good connection of the ends of the plug wires, of the secondary wire and of the primary wire with their terminals.

The plug wires should be clean and as far as possible from the exhaust pipes and ground of the engine. They should be supported at intervals sufficiently close to prevent wear of the insulating material due to friction.

Verify the insulation of the wires. Be sure that the insulation has not been damaged, especially at the ends of the assembly.

Be sure that the ground switch works properly and has clean contacts. If this wire is not a perfect conductor the engine will stop or it will be impossible to start it again.

Cooling.

(a) Air-cooling. Verify the cleanliness of the fins which should not be rusted or covered with a thick coating of oil, the latter being a poor conductor of heat.

(b) Water-cooling. Be sure that there is no loss of water from the water jackets, radiator, cocks, emptying plugs, pump or piping.

Be sure that the connection and the rubber joints are in good condition and well tightened. The rubber joints should yield to the touch and show no cracks or breaks. They should overlap considerably the point of attachment and should be secured either by clips or by several turns of annealed wire.

Verify the tightness of the joint of the water pump.

The water pump lubricator cup should be provided with sufficient grease to be screwed down half its height.

Verify the attachment of the radiator and its shell.

Verify the condition of the radiator water.

Be sure that the radiator shows no traces of rust. In case rust is visible scrape the affected part to see that it hides no leak. Be sure that the ventilating pipe in the radiator plug is not stopped up.

Verify the condition of the thermometer and its piping.

Lubrication.-

Verify the condition of the oil tanks and the tightening of the piping connections.

Verify the water tightness of the piping and examine the rubber joints as indicated in the preceding section.

Verify the attachment of the pump and the condition of the shaft and driving gears, if these parts are accessible.

Verify the condition of the filter.

Verify the excess pressure valve, if there is one.

Verify the condition of the oil in the crankcase and ascertain the number of hours the engine has run since the crankcase was last filled.

Engine Cowling.-

Verify the attachment of the engine cowling. See that there is no appreciable warping.

Engine Controls.-

Operate the engine controls and see that their condition is good.

Verify that the ends of the movement of the levers correspond

with the closing and opening of the parts controlled.

The axes should have no appreciable wear and should be well pinned.

Propellers.-

Be sure that the propellers are not split.

Be sure that the laminae which constitute the propellers are not unglued and that the wood has no bumps and is neither jagged nor split.

Be sure that the varnish is perfectly smooth and is not partially worn away.

Be sure of the good condition of the metal tipping and its attachment.

If necessary, verify the static balance of the propeller by placing it on a special support, using a dummy hub, where it should remain in balance in all positions.

When the propeller is in position verify its condition and be sure that it is properly attached by opening the blades successively into a vertical position, taking the end of the lower blade in both hands and giving it a sudden pull. No play should be perceptible in this test.

Verify the condition and tightening of the bolts of the hub.

See that the blocking and lock nuts are properly placed.

Be sure that the propeller when driving makes a perfect disk.

Be sure that the end of the propeller blade is always at a minimum of 40 cm (15.75 in.) from the ground, the airplane being

in line of flight and the shock absorbers in their extended position.

Verify the stamping of the propeller by the Aircraft Production Service.

Verify that the type of airplane and engine with which the propeller is used is that indicated on the hub by the constructor.

Engine Test at Fixed Point.-

This test is made only when there is any doubt as to the condition of the engine. With the engine running, advance ignition at maximum with the corrector closed, and see that the engine runs steadily and also that the explosions and the magnetos are regular.

Note the manometer readings as regards oil pressure; verify whether acceleration is free from defects, without backfire or misfiring.

Be sure that the engine can be stopped by setting the switch at "stop."

Pass the hand over the pump, radiators, cylinder jackets and intake pipes in order to make sure that the water is at normal temperature and circulating properly.

The heat indicator should not register more than 65° over the temperature of the surrounding air.

Verify the number of revolutions in idling and rectify, when necessary, by adjusting the block screws of the control lever of the butterfly valve of each carburetor.

Bench Test of Engines.-

If an engine has been overhauled or repaired, it should be

given an hour's bench test at various speeds; thirty minutes at least should be at the régime corresponding to nominal power and two minutes at the speed of open throttle.

This test shall include a measurement of power and consumption. The engine shall then be demounted and subjected to a twenty-minute verification test.

Exemption from the rule concerning the demounting of the engine may be accorded to companies or private persons who have had the method of overhauling approved by the S.N.Aé. or by the Bureau Véritas.

Power will be measured either by the hydraulic bench, or, the various parts of the instruments being first thoroughly tested, by the Froude brake, or a dynamometer. The results obtained with calibrated clubs are of no real value. In these measurements only ordinary or tractor clubs or propellers will be used, to the exclusion of pusher clubs or propellers. In the case of a tractor propeller no correction shall be made in the hydraulic bench.

A new production engine must undergo a five-hour bench test, of which half an hour will be at nominal power speed and two minutes at full throttle. The remainder of the test will be carried out at nine-tenths of nominal power, obtained by reducing the revolutions for nominal power speed by 1/30.

III. Upkeep.

Warm, soapy water is recommended for cleaning the fabric of an

airplane; the use of gasoline for this purpose should be strictly forbidden.

For cleaning varnished wood parts (struts, propellers), rub them with a cloth dipped in turpentine. In order to preserve the varnish, give it a thin coating of linseed oil now and then.

Metal parts which have slightly rusted should be scoured with very fine emery paper and then greased.

Important metal parts such as bracing wires, should be changed when very rusty.

A tear in the fabric should be stitched up, using small stitches and strong thread (Breton thread); a strip of fabric, wide enough to extend to at least 5 cm (1.97 in.) of each side of the join, should be glued over it. The threads of the edges of this strip must be pulled out to form a fringe, or the edges may be notched.

The radiators must be kept clean by being thoroughly flooded at frequent intervals.

If they are dirty or incrusted with tartar they must either be changed or thoroughly cleansed.

Spark plugs must be examined after each flight.

All hard rubber joints should be changed periodically. The edges of tubes joined by a hard rubber joint should be softened by filing.

IV. Repairs.

A - Materials.

1. Wood.- The woods used in making parts for repairing airplanes should, in principle, be of the same species as the part

to be replaced.

The wood should be dry, straight grain, without twisted fibers or knots. Knots of not more than 3 mm (.12 in.) in diameter may be tolerated, provided they do not go through the wood and are of healthy aspect.

The woods used should be homogeneous, that is, there should be but slight differences in the structure, thickness of layers, and color of the various parts of the manufactured piece.

The manufactured piece should not, in principle, show any flaw, neither checks, cracks, shrinkage, fracture, nor (in resinous wood) any resin pockets. It must also be free from worm holes.

Wood affected by dry rot, mould, or showing any trace of deterioration or rot are to be excluded.

The wood must be of normal color and odor.

Laminated wood.- Must be glued in such a way that the ply will not come apart, either under stress or owing to humidity.

Only sound wood must be used and the ply must be assembled in such a manner that no space is left between the layers.

2. Iron and Steel.- Must be free from cracks, scales, splinters and flaws generally.

Metals which are brittle, or have lamellated or irregular grain, are to be rejected.

A slight incision being made in the metal with a saw and the metal being then broken by a sharp blow, the fibrous texture should show metallic threads or a close, fine grain, homogeneous and fibrous.

Metal parts should be forged and well machined. Weldings must be well executed without oxide of iron. Re-entering angles should be strengthened by a circular channel.

These parts must be free from flaws and must be of exactly the same shape and size as the parts they are to replace.

Iron fittings must be painted, galvanized, or enamelled.

The protective coatings used must contain no ingredient likely to deteriorate the metal.

Bolts.- Eyebolts and turnbuckles should be able to stand being bent to an angle of 45° along a radius of not more than twice 1/3 of their diameter and then straightened by cold hammering without showing any signs of splitting or cracking. These parts must be stronger than the cables and piano wires they hold taut.

Sheet metal.- (Clips, attachment fittings, engine support, etc.). The sheet must be perfectly rolled and have a plane, uniform surface, entirely free from corrugations, blisters, cracks, or any other flaws.

Tubes must be free from scale, cracks, pitting or traces of oxide or dross which might give rise to pitting.

Piano wires must be free from all flaws (cracks, scale, etc.) These wires, held in a vise, must be able to stand being bent to an angle of 90°, straightened and bent in the opposite direction. The number of times this operation is to be repeated will depend on the diameter of the wire, and will increase as the diameter diminishes.

Aluminum and Duralumin.- Parts made of aluminum or duralumin must be sound and free from defects affecting the strength of the part. Parts for seaplanes, subject to stress, are to be doped with an approved varnish.

3. Fabrics.-

Fabrics having to support aerodynamic stresses must be pure linen and straight thread. They must be scoured with warm water and not calendered. The fabrics must always have passed the tests. If they have not been approved by the S.F.A., a tensile test must be performed on a specimen 50 mm (1.97 in.) wide after two hours' immersion in running water and then squeezed by hand between two sheets of blotting paper. The strength of the test specimen must not be less than 90 kg (198.4 lb.), that is, 1800 kg (3968 lb.) per meter.

In principle, cotton fabrics will only be used for wrappings.

3. Assembly and Gluing of Wood.- Most of the elements of wooden parts (struts, spars, ribs, etc.) to be assembled and glued are to be flat pieces with beveled edges.

Surfaces to be glued must be planed with a fine-toothed plane, in the way of the grain.

The chief kinds of glue to be used are:

a) Isinglass, colorless, kept liquid, and used cold.

b) Joiner's glue, used warm (colorless or white).

c) Chemical glues (usually white).

Glues to be used warm are good provided they are applied very hot and fluid and, as far as possible, in a well-closed room heated to a temperature of 30°.

Parts to be glued should first be heated, preferably with an iron or by means of heating tables rather than with a blow-pipe, so that the glue applied remains liquid until the parts are assembled, which should be done immediately by means of clamps, wire nails or screws.

Isinglass may be used for parts having a small bearing surface (cap strips of ribs, etc.). Chemical glue gives good results for all kinds of work, but some of these glues injure the wood. They should be tested before being used.

When glue is properly applied, it should form a fine, regular line.

It may be given a coat of formol to ensure the glue being imputrescible.

Wrapping.- This operation consists of gluing a strip of fabric around a part formed of several elements glued together.

When dry, see that the glue has been well and evenly applied and that there are no blisters on the strips. The strips should be stretched evenly and should hold well.

Wrappings are to be varnished.

Ribs.- The strips must be nailed with wire nails of the right length. The wood must not be splintered. Gluing and wrapping must be correctly executed.

See that the stays are placed in the right way.

See that the ribs are all in the same plan and that nothing is loosened or put out of shape when an attempt is made to twist them by hand. Be sure that the wrappings are correctly placed and tacked to the ribs.

C - Assembly by Iron Fittings and Bolts.

The assembled parts should not be weakened by holes for bolts or other attachment fittings. They must therefore be strengthened at the points of attachment, and where bolts pass through them.

Vertical bolts should be placed head up.

Bolts placed horizontally in the direction of flight should have the head forward.

A loop of piano wire badly made must never be straightened out and made again with the same wire.

D - Verification of Forms.

Elements manufactured for repairs should be scrupulously checked as to accuracy of form.

See that the wood is of the right thickness and that the spacings, curves and surfaces are accurate. For this purpose use gauges, templets and jigs.

Parts having defects of form, however slight, are to be refused, since safety depends not only on mechanical strength but also on the accuracy of form of all the elements.

E - Assembling.

Assembling a Wing.- The structural elements of a wing are to be assembled on the spars in the same positions as on the model.

They are to be attached in the same way and with screws or nails of the same length (the wood must never be splintered by a screw).

The diagonals of a rectangle, properly stretched, must be of the same length. The loop terminating each piano wire must have normal elongation. The ribs must be placed at the same angle with respect to the spars and attached in conformity with the indications given in the drawings of the model type approved by the S.T.Aé.

Check the spars and their respective positions.

Check the leading edge.

The frame of the wing must be varnished, the elements being

free from cracks or defects.

Check the position of the pulleys or control cranks. See that the pins are in the right position and well oiled.

Check the controls placed inside the wing.

F - Fabric Covering.

The fabric should be stitched on the straight, the warp being perpendicular to the leading edge (seam running from fore to aft).

Fabric stitched on the cross at 45° may be tolerated for airplanes having a speed of less than 140 km/h (87 M.P.H.).

The fabric must not be nailed to the ribs, but held in place by ties, the distance between the ties being in direct proportion to the speed capacity and load per cubic meter of the airplane.

The ties are to have a wide strip of fabric glued over them.

The space between two ties must not be less than:

Spad 33	0.015 m (.59 in.)	at center
	0.04 m (1.57 in.)	middle of wing
	0.10 m (3.94 in.)	at tips
Potez IX	0.04 m (1.57 in.)	at center
	0.10 m (3.94 in.)	at tips
Goliath	0.10 m (3.94 in.)	everywhere.
Breguet 14	0.10 m (3.94 in.)	doubled at 0.01 from center
	0.10 m (3.94 in.)	at tips
Salmson	5.05 m	at center
	0.08 m (3.15 in.)	at tips

In a general way, the minimum space between two ties is given in meters by the formula $\frac{n}{100d}$, n being the number of strands for

each tie and "d" the space, in meters, between two ribs. This space should be reduced by one-half for high speed airplanes loaded per square meter, comparable to army combat airplanes.

The yarn utilized should have a tensile strength of 10 kg (22.05 lb.).

For old type airplanes, on which the fabric is nailed, the following rules are to be observed:

a) The nails employed must be of brass or galvanized iron.

b) One nail out of three will be replaced by a screw.

c) A strip of fabric must be glued over the line of nails.

G - Doping.

The dope must be fluid.

The doping of fabric should, as far as possible, be carried out in well-ventilated premises kept at a constant mean temperature.

In principle, the fabric should be given four coats of dope, each coat being rubbed with pumice stone when dry; or three coats of dope with a final coat of oil varnish. The second alternative is not recommended.*

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* Formulae for dopes having given good results (for 1000 g (33.81 lb.):

Colorless dope: A -	Cellulose acetate	80 g	(2.71 oz.)
	Acetone	410 "	(13.87 ")
	Benzyl alcohol	40 "	(1.35 ")
	Denatured alcohol	235 "	(7.94 ")
	Benzine	235 "	(7.94 ")
B -	Cellulose acetate	80 "	(2.71 ")
	Methyl acetate	500 "	(16.91 ")
	Benzyl alcohol	40 "	(1.35 ")
	Denatured "	190 "	(6.42 ")
	Benzine	190 "	(6.42 ")

(Continued at bottom of page 34.)

H - General Assembling.

Check the assembling of wings, body, landing gear and engine as indicated in the chapter on Inspection.

In the body, see that all wires have the right tension and that the loop at the end of each piano wire has normal elongation.

See that all screws and turnbuckles, both in cellule and fuselage are locked.

Examine the splicings of the control cables.

The strands of the cables must be suitably twisted together and then wrapped around with a wire. The wrapping must be slanting and there must be at least a dozen turns round the cable.

The splicings will be made with 5 1/2 end strands passing through the eye and whipped with brass wire. The whipping must overlap the free end of the splice and spread over it, leaving, however, the first end strand free so that it can be checked.

Formulas for dopes having given good results (for 1000 g (33.81 lb.) continued.

Colored dope: A -	Cellulose acetate	75 g	(2.54 oz.)
	Acetone or Methyl acetate	550 - 600g	(18.6 - 20.3 oz.)
	Benzyl alcohol	40 g	(1.35 oz.)
	Coloring matter	100 - 75"	(3.38 - 2.54 ")
	Denatured alcohol	105 - 115"	(3.55 - 3.89 ")
	Benzine	105 - 115"	(3.55 - 3.89 ")

Modifications.

Airplanes which have been modified in such a way as to change the balance in flight, the method of control or the characteristics must be made the subject of a special report and can only be placed under Classification V when the modifications have been approved by the Under Secretary of State for Aeronautics (S.T.Aé.).

The modifications to be noted in particular are:

1 - Change in the distribution of the load.

2 - Displacement of fuselage, fore or aft.

3 - Substituting an engine of weight and power different from those of the engine first adopted.

4 - Addition to number of engines or displacement of existing engine or engines.

5 - Increase or decrease of control surfaces.

6 - increase or decrease of wing area.

7 - Change in position of control levers.

8 - Replacement of parts (wings, struts, bracing wires, controls, propellers, wheels, etc.) by spare parts not having the same technical specifications as the original parts.

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